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On the NATURALIZATION of PLANTS. By JOHN TEMPLETON, A L.S. communicated by the BISHOP of CLONFERT.

THE naturalization of plants is an object of such importance, and a subject that is at present so little understood, that any attempt to extend our knowledge of it, however trifling, may still tend towards improvement, and perhaps serve as a foundation, on which at some future period a more perfect structure may be erected. Many experiments are yet wanting, much remains to be yet done, and, like other branches of knowledge, it will require the united efforts of numbers to bring it to perfection.

Read, Nov. 23,
1799.

THE same Almighty hand that formed the earth, has scattered in far distant regions vegetables which the necessity or luxury of man excites him to endeavour to accumulate about his home. And if we at the present time survey the different nations of the earth, we will find that most of them have received great and important benefits by the introduction of foreign plants; and that there is no country, however numerous its collection of plants, but may yet receive considerable advantages by the naturalization of others.

BOTANY,

BOTANY, a science which every one engaged in the study of will readily acknowledge to afford one of the purest of human pleasures, from the introduction of exotics derives its principal support; and certainly whatever tends to facilitate this amiable study is truly deserving of the attention of every philanthropic mind. As all botanists cannot have an opportunity of examining plants in their native soils at proper seasons, it is therefore only by transplanting and cultivating, they can become acquainted with the productions of distant countries; and to cultivate them with success we must derive our information principally from the plants themselves: each has certainly a peculiar character, which were we truly acquainted with, those tedious experiments with each newly acquired species, which now nearly exhaust the patience of all lovers of plants, would be no longer necessary; gardening might then boast of being established on scientific principles, and would then never adopt rules contrary to what nature dictates.

Nor will she, scorning truth and taste, devote
 To strange and alien soils, her seedling stems;
 Fix the dark fallow on the mountain's brow,
 Or to the moss-grown margin of the lake
 Bid the dry pine descend. From nature's laws
 She draws her own: nature and she are one.

MASON'S ENGLISH GARDEN, B. 111, line 226.

By

By our present imperfect knowledge of the physiology of plants, we are necessitated to accept of every assistance within our reach: and plants being so immediately connected with every modification of the atmosphere, meteorology, which has hitherto been considered as an object of curiosity, is a source from which we may derive much useful information.

HEAT being found to increase or decrease nearly in a regular progression, according to the degrees of latitude, if the latitude of the place where a plant is found be known, by consulting Mr. Kirwan's Table of the Mean Annual Temperature of different Latitudes*, we may find whether the temperature nearly corresponds with our own. Or, supposing the mean annual temperature of Dublin, lat. 52° , equal 50 of temperature, by adding one for every degree of latitude southward, and subtracting one for every degree of latitude northward, we have the temperature correctly enough for our purpose. For these calculations need not be carried to the greatest degree of correctness, as we know that, if we except a few, plants have a considerable range of latitude; those which cannot bear frost, being found to extend from the northern to the southern verge of the torrid zone, and many of those which grow on the southern limits of the temperate, to approach the borders of the frozen zone. Thus of the Lapland

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plants,

* See an Estimate of the Temperature of Different Latitudes by R. Kirwan, Esq; page 17.

plants near three hundred are found in the environs of Paris*, many of them much farther south, and some, as the Water Lillies (*Nymphæa*), Sundew (*Drosera*), Arrow-head (*Sagittaria*), &c. even natives of India †.

IN the latitude 44° on the European, and 34° on the American continent ‡, it is not unusual for water to be frozen in January; and as some seasons are much more severe than others, plants growing considerably farther to the southward would be liable to suffer by cold in such seasons, if nature had not provided a remedy by their manner of growing, which enables them to resist the cold of such rigorous seasons; and on this account many of them will be found to thrive, when transplanted nine or ten degrees further north than their native stations.

FROM antient authors it appears that Italy formerly experienced the same degree of cold as the American continent under the same parallel of latitude does at present. Therefore it is highly probable, that Italian plants not introduced into Italy since that time, might in a series of years be changed from their now tender to their once hardy state.

BUT

* See *Flora Lapponica* & *Thuillier's Flore des Environs de Paris*.

† See *Hunters Evlyns Sylva*, p. 552.

‡ See *Kirwan on the Temperature of Different Latitudes*, p. 50.

BUT in conducting such an experiment as the naturalization of plants from a southern to a northern climate, so many minute circumstances require our attention, that few people have either time or patience to reach the wished for goal.

BUT a careful attention to the characters which the plants themselves present, will enable us to proceed with more certainty, and hopes of having our endeavours crowned with success.

By the appearance of the roots and leaves we may nearly determine in what kind of soil the plant is most likely to thrive. Robust roots and fleshy or rigid leaves require a dry soil, according to their thickness; stiff clay or sandy loam, as beans, peach, and apple trees; robust spongy roots which have a tendency to mat near the surface with thin leaves, as the Alder (*Betula* *Alnus*), Willows (*Salix*), require a somewhat stiff soil with moisture; many of the *Salix* genus will not grow with their accustomed vigour, in a light turfy or peat mold soil, for want of the necessary resistance to the roots, although suitable in respect to moisture. Slender, hard and wiry roots, as those of the pine, *Cistus*, &c. require dry, sandy, or gravelly soils. And extremely fine and hairlike roots, as those of *Erica*, *Halmia*, *Rhododendron*, &c. must have a soil whose particles will not impede the shooting of their tender fibres, and with a small but regular degree of moisture, that the roots, which by their form cannot resist the slightest drought, may not be destroyed. Plants in a warm climate

perspire more than in a cold one ; so in a warm they require much, and in a cold one little moisture. Therefore, when transplanted from a warm to a cold climate, they should have a dryer soil, and from a colder to a warmer, a moister one, than their native station.

IN the first case, not being able to perspire the superabundant moisture, they will be rotted ; and in the last, not having moisture sufficient to supply the loss by perspiration, the growth will be slow, disease and death will follow, unless they receive a timely supply of moisture : by the red or yellow colour of the leaves we may discern the approach of the first evil, and by the stunted growth, and small curled leaves, that of the last. A large quantity of pure circulating fluid seldom injures plants, but stagnant water is certain destruction to almost every vegetable.

AFTER having determined the most suitable soil, we must afterwards strive to give each plant a proper situation. It is well known, that plants from a shady will not thrive well in an open, nor plants from an open in a shady situation. But the necessity of a natural situation is by no plant more evidently illustrated than by the common myrtle (*Myrtus Communis*). Even at Glenarm, in the latitude $54^{\circ} 56' N$ it grows with great luxuriance contiguous to the sea, and braves our coldest winters ; yet all attempts to naturalize it in an inland situation, several
degrees

degrees farther south, and in a much more genial climate, have hitherto proved unsuccessful. The olive tree cannot possibly be cultivated in the interior of Asia or America, though the latitude be in other respects favourable, nor is it fruitful when excluded from the sea breezes*.

THE cause of this may be that near the sea the temperature is more regular than within land, and sudden changes are perhaps unfavourable to evergreens: for we always find those with broad leaves grow best in the shade, and those with narrow leaves on elevated places, in both of which situations the temperature is more regular than in open exposures or confined vallies. And we may often observe plants growing on a somewhat elevated situation, if sheltered from strong winds, less hurt in a severe winter, than others in low warm and sheltered places. For vapour being raised in such places during the day, produces a greater degree of cold by condensation and evaporation in the night, than is experienced in other places where the coldness of the air prevented the rise of vapour during the day. From every observation it appears, that those plants which have the least sap in winter, or whose sap is of a resinous or oily nature, suffer least from cold, and that the principal cause of destruction is the vessels being burst by the freezing of the sap. The hoar-frost, which is always most abundant in vales, tends in a great degree to promote
this;

* See Saint Pierre's *Studies of Nature*, translated by Hunter, Vol. I. page 607. Dublin Edition.

this; for being changed into water, part only of this water is evaporated during the day, the rest remains to be converted into ice by the cold of the ensuing night. This icy covering increases the cold, till the vital principle*, and resistance given by the formation of the bark to the entrance of cold, are overcome, the sap frozen, and at the same time the vessels burst by the expansive force of freezing. This gives the reason why plants in a situation where the sun does not shine on them to thaw the hoar-frost, suffer least in severe seasons; and that plants removed in Autumn, unless the shoots are completely hardened, will be more liable to be injured by frost than those of the same species, the descent or fixation of whose sap has received no check by transplanting. Miller remarks, that those plants which were removed in the Autumn of 1739 were mostly killed by the cold of the ensuing winter, while many of the same species escaped uninjured: and the same may be always observed after every severe winter.

Few deciduous shrubs agree with shade: their natural place is the sunny outskirts of the forest; and when otherwise situated,
long

* See Smith's Tracts relating to Natural History, page 177, and Philosophical Transactions for 1788.

† The following experiments may throw some light upon the cause of plants remaining unfrozen, when the surrounding water is frozen. Water enclosed in sealed glass globules remains unfrozen, till the thermometer descends to twenty-four; unsealed ones freeze and burst immediately on being cooled down to freezing water. Oil enclosed in the same kind of globules continued unexpanded, and consequently the globules unbroken, when placed in a mixture of snow and sal ammoniac, and cooled below 0.

long and slender branches, with large thin leaves, shew their unhealthy state. From these the climbing plants are easily distinguished by their tendency to contortion, or shooting forth roots or tendrils. To the deciduous climbers a slight shade is not hurtful, as it is only there they can find the necessary support; but in the deep recesses of the forest, the evergreen climbers will spread around their tangling branches, and thrive with wild luxuriance,

Where scarce a sunbeam wanders through the gloom.

THOMSON'S SEASONS.

never appearing, if the soil is sufficiently moist in summer, to be hurt by the thickest shade of deciduous trees.

THE shade is also the natural situation for young plants. By the parental shade they are protected from the drought of Summer, and the cold of winter. The more a plant is shaded in winter, and the nearer it is to any large body, the less danger it will be in of suffering from frost. For when a plant or water is so situated as to be overtopped by trees, a great part of the hoar or frosty particles, which would fall on it, is intercepted. Under trees we may often observe water unfrozen, and plants unhurt by the severity of cold, and many retaining their leaves; when water at a small distance is frozen, and plants of the same species, but unshaded, lose their leaves and suffer considerably. As large bodies are not easily cooled, the cold is in some degree mitigated by the
stems

stems of large trees. That this is the case may be perceived, the twigs and smaller branches being covered with hoarfrost, when the trunk and larger branches remain uncovered.

Dr. WILSON of Glasgow observed, that when a great degree of cold prevailed, palisades extending outward from a house, and also from a large pillar, were covered with hoarfrost, in the most regular manner, according to their proximity or distance from the house or pillar, those next the house or pillar remaining free from hoarfrost, while the more distant ones were entirely covered*. This accounts for the fig-tree shoots, mentioned by Miller, being killed when growing out from the wall, at the same time when the other shoots close nailed to it escaped unhurt†. From this circumstance, most people have affixed those plants which they wish to naturalize to the climate against walls. But when put to a wall, care should be taken that they are sheltered from strong winds, which generally injure the leaves and young shoots, thereby destroying the plant if it is not vigorous. On this account the stems of large trees are preferable for climbing plants, and there they must always be more admired as appearing more natural.

BUT instead of affixing to walls those plants which require no support, we might cultivate them in pots or boxes, which may
be

* Philosophical Transactions, Vol. lxx, p. 471, 2.

† Miller's Dictionary, Article Ficus.

be placed in their proper exposure during the summer, and, until their hardiness is determined, removed under the fir or other trees in winter, the thickness of whose shade ought to be proportioned to the apparent tenderness of the plant.

THESE pots or boxes should be always sunk in the earth, and in winter the surface covered with moss. The drier the ground the better, for sunken pots are liable to be too damp.

THE best manner of treating *Ericas* is to place them in a proper situation in the spring, and on the approach of severe weather to fix branches of spruce-fir about them, augmenting the covering as the cold encreases. But as the cold seldom becomes suddenly severe, and a slight frost does them little injury, the *Erica Tubiflora*, one of the most tender, bearing about 29° of Fahrenheit's thermometer; it is best not to begin covering too soon, lest, as they are plants that require a very small degree of heat, they should be made to shoot, in which case the slightest frost will perhaps destroy them. To protect herbaceous plants from frost, moss is the most proper covering, by remaining alive through the winter; even after being pulled up, it is not liable to heating and putrefaction, as all dead vegetable substances are, by which they impart to the plant heat and moisture (the two principal agents which cause vegetation) thereby putting the vegetating powers in action, and filling the plant with sap, at an improper season. In our culture of annuals our only care is di-

rected to placing them in proper soils and exposures. For, that no region of the earth should remain uninhabited, with a liberal hand have the annual plants been distributed; from these do men and animals derive their principal support, and of all the vegetable kingdom, they are best adapted for naturalization. By bringing their seed to perfection in a single season, they are capable of cultivation in a greater variety of climates than any other vegetables. And the seed, being equally undestroyed by natural heat and cold, lies dormant, till genial weather calls forth its latent powers, and urges it to vegetation, whether among the frozen snows of Siberia, or the burning sands of Africa. The *Refeda odorata* (Mignonette), a native of Egypt, and *Helianthus annuus* (Sunflower), of Mexico and Peru, ripen their seed, and are thereby perpetuated in our northern latitudes. St. Pierre * says, the peasants of Finland cultivate tobacco (*Nicotiana Tabacum*), with success, beyond the sixty-first degree of latitude; and that barley succeeds in the very bosom of the North. Amidst the rocks of Finland he saw crops of this grain as beautiful as ever the plains of Palestine produced †.

WHEN we endeavour to naturalize plants, that we may distinguish those which offer the fairest prospect of success, a comparison of the exotics with the natives of the soil will be our surest

* See St. Pierre's *Studies of Nature*, translated by Hunter, Dublin Edition, Vol. I, page 604.

† See same Work, page 667.

surest guide. Thus we find, that throughout the frosty regions of the north, the trees, shrubs, bulbous and perennials, complete their shoots, and, before the cold of the winter commences, enclose in hybernacule or scaly buds, the embryo for the coming year. And there is every reason to believe that all exotics which cease growing, and form these buds or hybernacule in the open air during the course of our summer, will not suffer from the severity of our winter. In the hot-house many plants complete their shoots that would not probably do so in the open air, the heat not being sufficient to cause them to grow with the vigour necessary for their completion before winter. Nevertheless many of these, if not all, might be brought, by enuring them to the open air, to bear our climate. The *Camelia Japonica* *Thea viridis* and *Calycanthus præcox*, which were formerly kept in the hot-house, then in the green-house, are now sufficiently naturalized to grow in the open air, and are as little injured with the cold of our winters as either the common or Portugal laurels.

SOME exceptions to this observation seem to present themselves. The *Robinia Pseudo Acacia* (two-thorned *Acacia*) does not form external hybernacule, nor complete its shoots, yet grows well in our climate; it however, when the frost comes on early, loses a great part of its summer shoots. Several species of the *Cistus*, that cease growing on the approach of winter, but form no hybernacule, live through our mild winters, but suffer greatly

in severe frosts. And others, as the *Laurustinus* (*Viburnum tinus*) continue to shoot and flower, unless the frost is severe throughout the winter, sustained by their vitality, or that principle whose existence preserves plants unhurt by cold before flowering, but which ceases to exist when the parts of fructification have performed their office *.

THE *Laurustinus* is one of those plants that were introduced to Ireland before green-houses were known, consequently planted in the open ground, and experience shews that it is seldom hurt by frost. By it we find that some plants, which to appearance are not fitted for our climate, do yet outlive our winters; and that, without a knowledge of their native stations, we may sometimes suppose plants to be tender which are really hardy: thus the *Laurustinus* is unhurt by frost in Ireland until the cold exceeds that of its own climate. The *Buddlea globosa* and *Fuschia coccinea* are other instances of plants, that without a knowledge of their native climate, Chili, we would not suppose capable of being naturalized to ours. Yet is the *Buddlea* seldom injured by our cold, and the *Fuschia*, although killed to the ground by the winter's cold, sends forth abundance of shoots which attain the height of three feet in summer, and are decorated with its elegant flowers, which are larger and much more brilliant than ever they are when confined in a house.

AND

* See Smith's Tracts, page 177, and Philosophical Transactions for 1788.

AND there is little doubt but many plants of Chili, and even those which grow within the tropics, when found near the elevation of perpetual frost, would bear the cold of Spitzbergen; for on the tops of mountains are found the plants of the plains of more northern latitudes. Thus is the *Salix herbacea* of Lapland and Spitzbergen found on the tops of Mourne mountains at about the elevation of 2,500 feet. On the Serra of Madeira, latitude 32° , $38'$, and elevated 5,162 feet, is found the *Erica Arborea*, of the neighbourhood of Genoa, latitude 44° , $25'$ *, Therefore as the temperature which prevails at the elevation of 5,162 feet, in latitude 32° , is found nearly to correspond with that of 51° north: the *Erica Arborea*, which grows at that elevation in latitude 32° , will find a climate suited to its nature in latitude 51° †. But as the before mentioned plants have a considerable range of latitude, it may be cultivated farther north when the soil and situation are favourable. At James Holmes's, Esq. on the eastern shore of Carrickfergus bay, four miles north of Belfast, there is a plant in the greatest vigour at the present time (July 1799) which has now stood uninjured three as severe winters as Ireland ever experienced, viz. 1794, 5, 1797, 8, and 1798, 9.

THE

* See Sketch of a Tour on the Continent, by J. E. Smith, M.D. F.R.S, &c. page 200, Vol. I.

† On dividing 15,577, the height of perpetual frost at the equator, by the difference of the temperature above and below, it is found that every 299 feet of elevation

THE situation is however favourable, being against a western wall facing the sea, and well sheltered by distant trees from strong winds. And in the neighbourhood of the sea I have little doubt but it would grow still farther north.

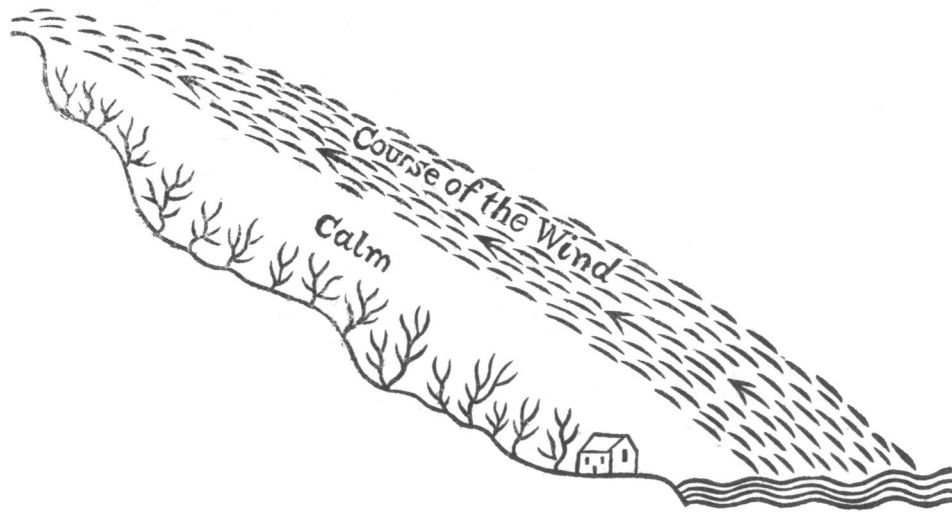
THE sea air has generally been reckoned a powerful obstacle to having plantations on its shores. But many observations have convinced me that it is the wind alone which prevents the growth of trees on the shores of the sea. And that on a large plain, where the winds are unimpeded in their course, the same difficulty of raising plantations as on the margin of the ocean will be experienced.

IN Forster's Account of Cook's second Voyage, it is mentioned, that the trees on New Zealand were growing so close to the edge of the water, that the ship's masts were entangled among their branches; and in particular situations the same proximity of trees to the sea might be observed in various latitudes. At Fairhead, the most northerly extremity of Ireland, and exposed to the fury of the Northern Ocean, the *Sorbus aucuparia* (Mountain Ash), *Betula alba* (Birch), *Quercus Robur* (Oak), with other indigenous trees, grow luxuriantly within 15 or 20 yards

variation lessen heat 1° , and on dividing 5,162 feet by 299, we have 17° , which subtracted from 69 mean annual temperature of latitude 32° , give 52, for the Serra of Madeira, corresponding with the latitude 51° (1).

† See Kirwan's Table of mean annual temperatures.

yards of high-water-mark. The reason of this appears to be that they grow upon the lower part of very high land, which causes an eddy to be formed about them when the wind blows from the sea ; and by the same high land they are protected from the south and south-west winds. The situation might be represented thus :



On the top of the rocks the wind rages with the greatest fury, even the grass seeming blighted, whereas below the rocks every plant appears in a thriving state, and some houses situated on the lower part never have their thatched roofs disturbed by the storms. In every other part along the coast where land is of
the

the same form it is covered with thriving wood, but where the land is nearly level for a length of way inland no wood appears, and every hedge is seen never to rise higher than the top of the bank which protects it from the wind. Therefore in order to plant near the sea on a low shore, it is necessary to commence the plantations a considerable way inland, and to allow the young trees to have others several feet taller than themselves behind them: these will have the same effect as high land, for by means of the opposition offered by innumerable stems and branches the force of the wind will be greatly lessened; as we may find by standing on the windward side of a thick wood during a storm, where, if the trees are lofty, the wind is much less violent than on an open plain. In water the effect of this kind of opposition is visible, for if into the bed of a swift stream we drive a number of stakes, the water, although it continues to flow, yet has its velocity diminished considerably.

Our first plantations in an exposed place ought always to be of such trees as are natives of mountains, for these are fitted by nature to bear the rude blasts of winter, and by the stiffness of their leaves, or flexibility of their footstalks, to remain uninjured by a summer storm. Of the first, we have the various race of pines; of the last, the Birch, the Aspen and the Mountain Ash*.

THUS

* Among the rocks of Agnew's Hill in the County of Antrim, I found the *Populus tremula* (Aspen Tree) growing luxuriantly on the eastern face, at about
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THUS by a careful inspection of the operations of nature, is the hand of man enabled to collect the productions of distant countries around his home, cover the arid heath with waving green, and make the lonely wilderness assume a pleasing gloom.

the elevation of 1,450 feet. And on the top of Slemish, the *Sorbus aucuparia* (Mountain Ash) exposed to every storm at the elevation of 1,398 feet.